NSC#1

Pythonect-Fu: From `Function()` to Language

Itzik Kotler
(Creator and Lead Developer of Pythonect & Hackersh)

Domain-specific Language

- Domain-specific language (DSL) is a mini-language aiming at representing constructs for a given domain
- DSL is effective if the words and idioms in the language adequately capture what needs to be represented
- DSL can also add syntax sugar

Why?

Why create a custom tag or an object with methods?

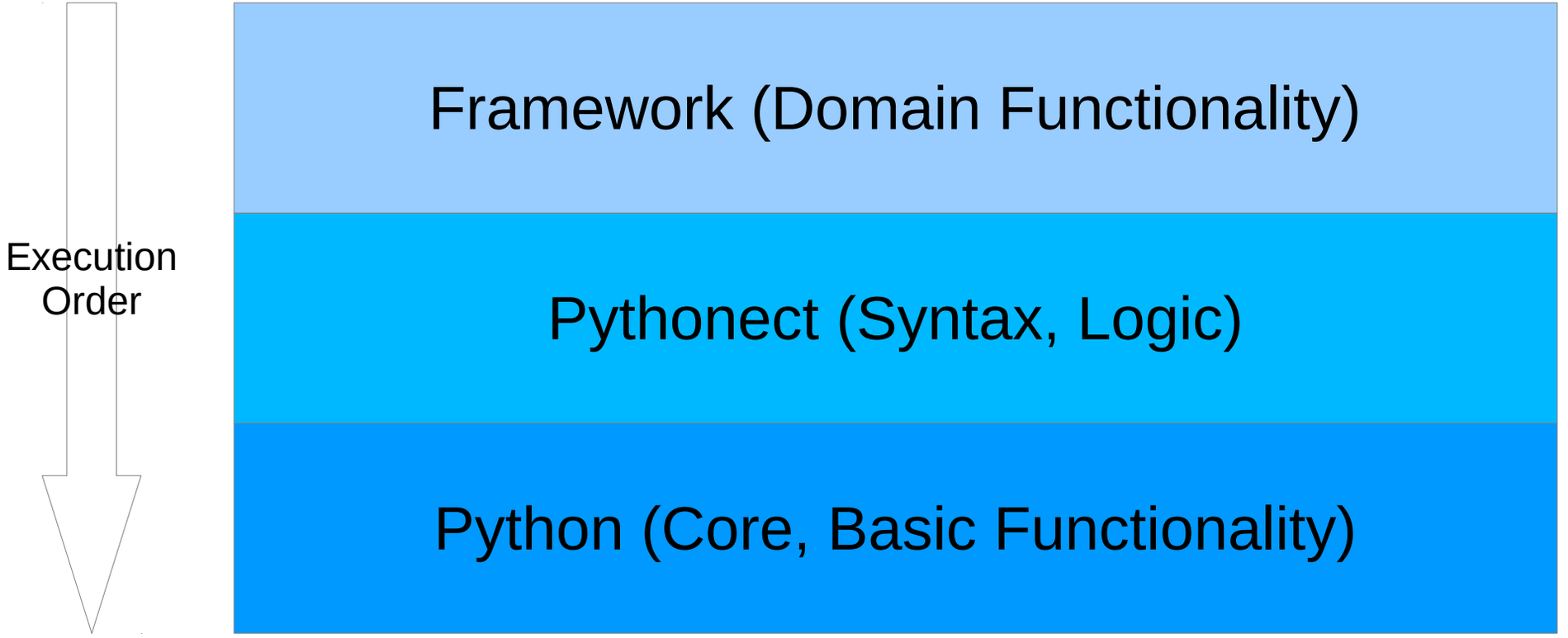
Elegant Code Reuse

Instead of having to recode algorithms every time you need them, you can just write a phrase in your DSL and you will have shorter, more easily maintainable programs

Example for DSL's

- Programming Language R
- XSLT
- Regular Expression
- Graphviz
- Shell utilities (*awk*, *sed*, *dc*, *bc*)
- Software development tools (*make*, *yacc*, *lex*)
- Etc.

Typical DSL Powered by Pythonect



Pythonect

- *Pythonect* is a portmanteau of the words Python and Connect
- New, experimental, general-purpose dataflow programming language based on Python
- Current “stable“ version (True to May 15 2013): 0.5.0
- Made available under 'Modified BSD License'
- Influenced by: Unix Shell Scripting, Python, Perl
- Cross-platform (should run on any Python supported platform)
- Website: http://www.pythonect.org/

A few words on the Development

- Written purely in Python (2.7)
  - Works on CPython 2.x, and Jython 2.7 implementations
- Tests written in PyUnit
- Hosted on GitHub
- Commits tested by Travis CI

Installing and Using The Pythonect Interpreter

- Install directly from PyPI using easy_install or pip:
  - `easy_install Pythonect`

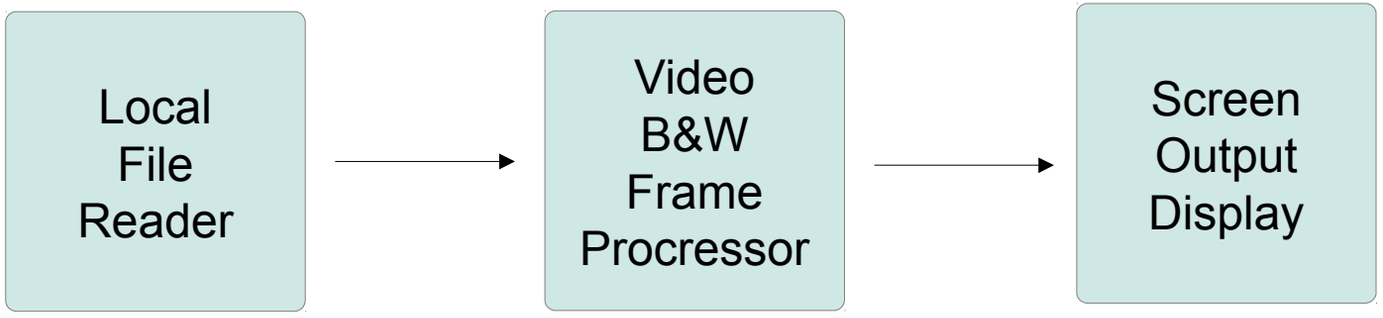
    OR
  - `pip install Pythonect`
- Clone the git repository:
  - `git clone git://github.com/ikotler/pythonect.git`
  - `cd pythonect`
  - `python setup.py install`

Dataflow Programming

Programming paradigm that treats data as something originating from a source, flows through a number of components and arrives at a final destination - most suitable when developing applications that are themselves focused on the "flow" of data.

Dataflow Example

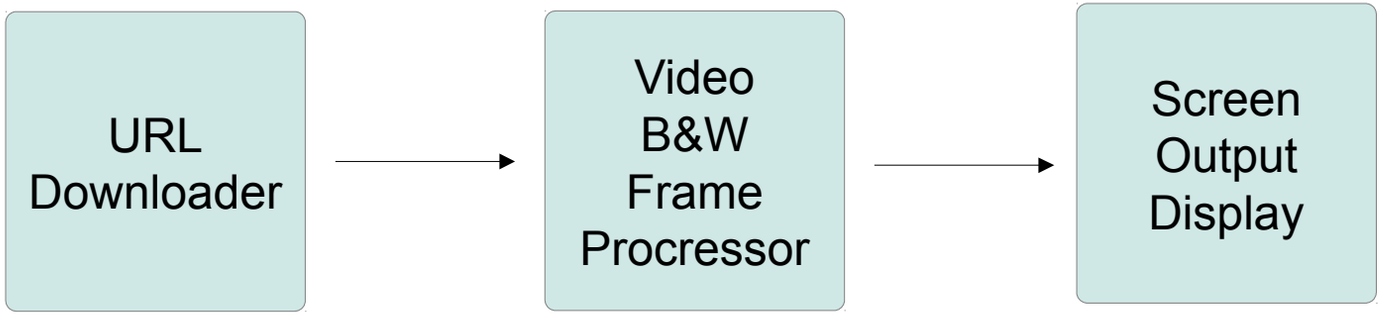
A video signal processor which may start with video input,
modifies it through a number of processing components (i.e. video filters),
and finally outputs it to a video display.



Dataflow Example

Want to change a feed from a local file to a remote file on a website?

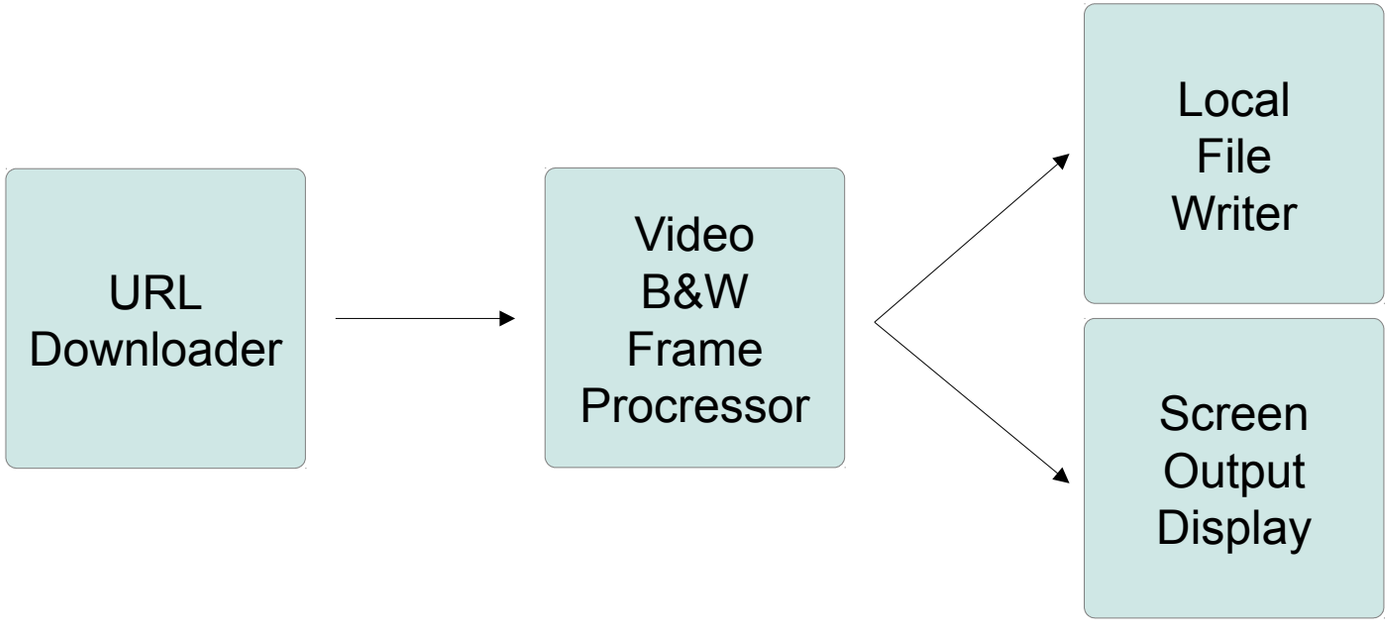
No problem!



Dataflow Example

Want to write the Video B&W Frame Processor output to both a screen and a local file?

No problem!



Dataflow Programming Advantages

- Concurrency and parallelism are natural
- Data flow networks are natural for representing process
- Data flow programs are more extensible than traditional programs

Dataflow Programming Disadvantages

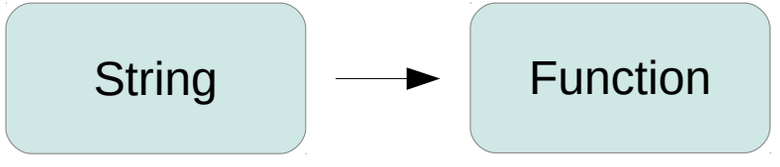
- The mindset of data flow programming is unfamiliar to most programmers
- The intervention of the run-time system can be expensive

Dataflow Programming Languages

- Spreadsheets are essentially dataflow (e.g. Excel)
- VHDL, Verilog and other hardware description languages are essentially dataflow
- XProc
- Max/Msp
- ... Etc.

<Pythonect Examples>

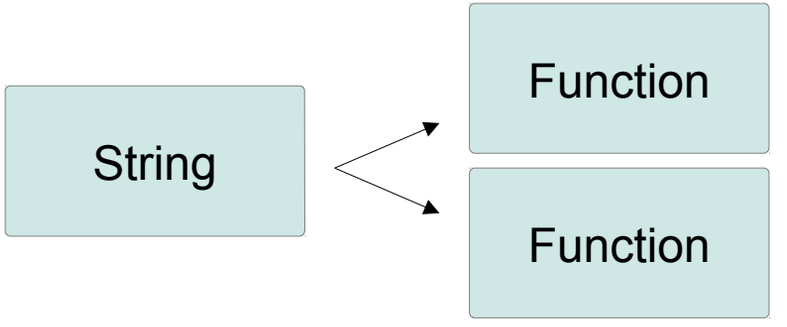
```
'Hello, world' -> print
```



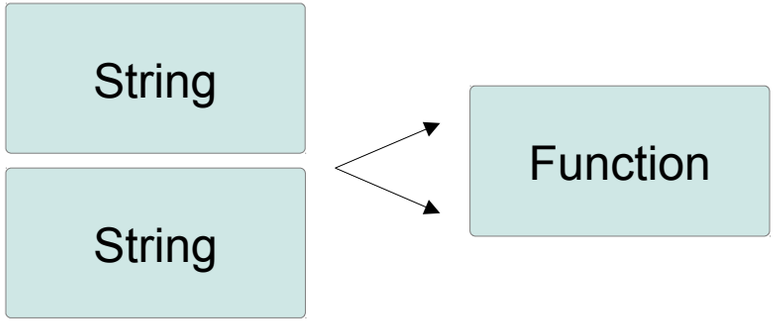
What do we have here?

- `->` is a Pythonect Control Operator, it means async forward.
- There's also `|` (i.e. Pipe) which means sync forward.
- `'Hello, world'` is a literal string
- `print` is a function

```
"Hello, world" -> [print, print]
```



```
["Hello, world", "Hello, world"] -> print
```



Basic Pythonect Syntax Summary

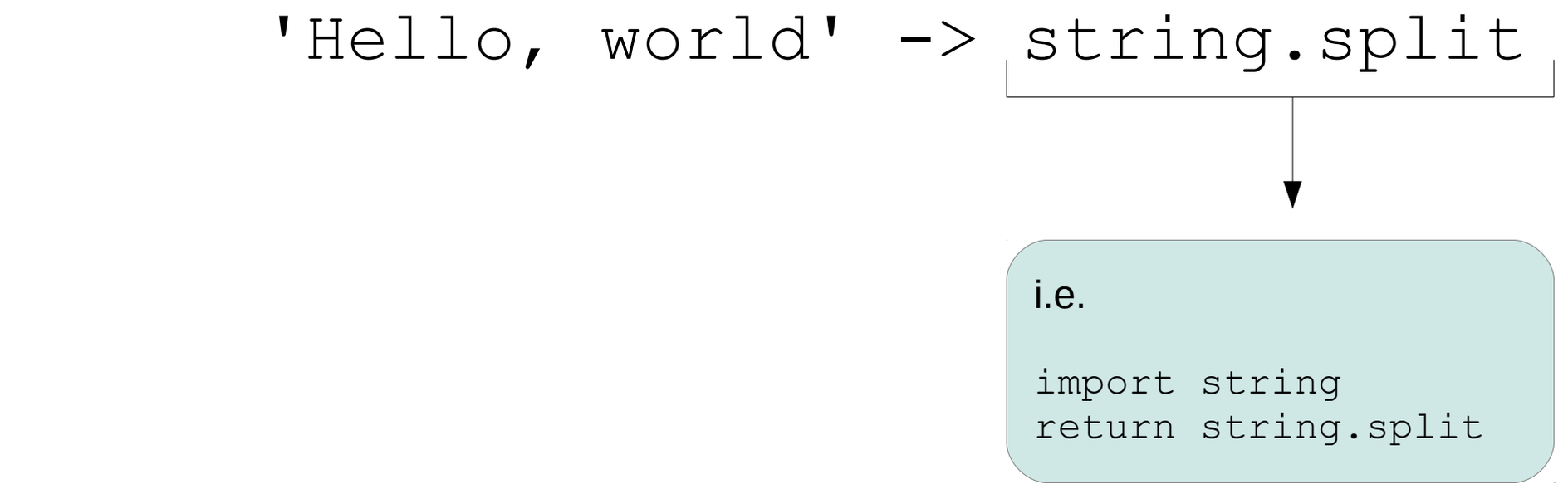
- `->` is async forward.
- `|` (i.e. Pipe) is sync forward.
- `_` (i.e. Underscore) is current value in flow

Domain-specific Language with Pythonect

- Pythonect provides various features to let you easily develop your own DSLs:
  - Built-in Python module Autoloader
  - Concurrency (Threads & Processes)
  - Abstract Syntax (i.e. Generic Flow Operators)

Built-in Python AutoLoader

- The AutoLoader loads Python modules from the file system when needed
- In other words, no need to `import` modules explicitly.
- The sacrifice is run-time speed for ease-of-coding and speed of the initial `import()`ing.


'Hello, world' -> string.split
i.e.
import string
return string.split

Concurrency (Threads & Processes)

- Multi-threading:
  - `'Hello, world' -> [print, print]`
- Multi-processing:
  - `'Hello, world' -> [print, print]`
- Mix:
  - `'Hello, world' -> [print, print &]`

Abstract Syntax

- Brackets for Scope:
  - `[]`
- Arrows and Pipes for Flows:
  - `|` and `->`
- Dict and Logical Keywords for Control Flow:
  - `{}` and `not/or/and`

So, imagine the following is a real script:

```
from_file('malware.exe') \
    -> extract_base64_strings \
        -> to_xml
```

IT IS!

(with Pythonect)

Meet SMALL

Simple **M**alware **A**na**L**ysis **L**anguage

- Toy language for analyzing malware samples
- Single Python file (14 functions, 215 lines of text)
- Runs on top of Pythonect

SMALL Features

- Extract IPv4 Addresses from Binaries
- Extract Base64 Strings from Binaries
- Calculate MD5/SHA1/CRC32
- Determine File Type (via /usr/bin/file)
- Create XML Reports

How Does SMALL Work?

- SMALL functions are divided into two groups:
  - Root, these functions start a flow
  - Normal, these functions continues or closes the flow
- Root functions accept `String` and return `dict`
  - e.g. `from_file()`
- Normal functions accept `dict` and return `dict`
  - e.g. `extract_base64_strings()`

<Pythonect/Security DSL (i.e. SMALL) Examples>

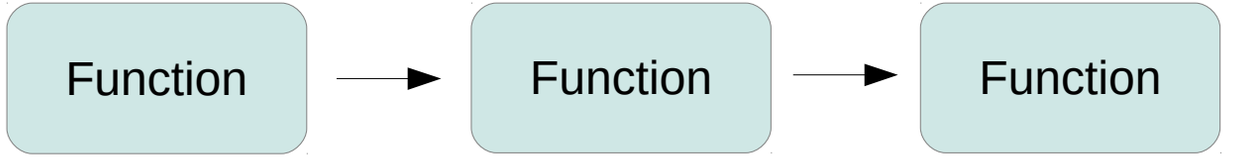
How to Start the SMALL Interpreter

```
pythonect -m SMALL -i
```

- The '-m' means - run library module as a script
- The '-i' means - inspect interactively after running script
- Just like Python :)

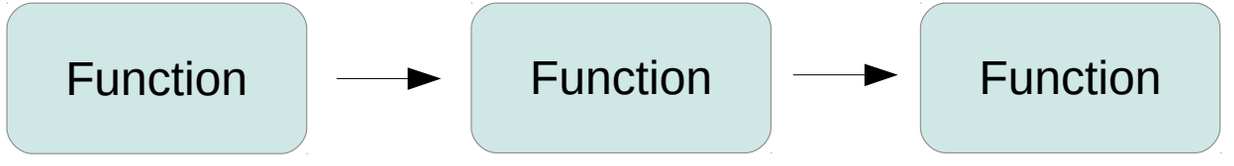
Extract Base64 Strings and Save As XML

```
from_file('malware.exe') \
    -> extract_base64_strings \
        -> to_xml
```



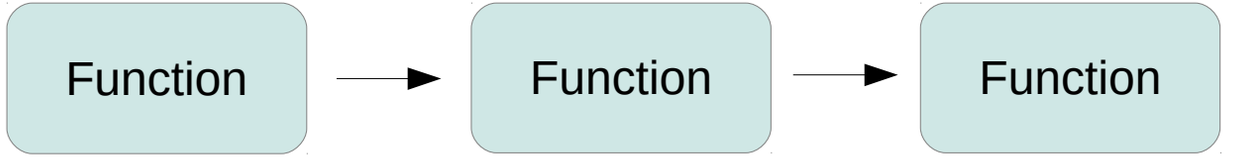
Extract IPv4 Addresses and Save As XML

```
from_file('malware.exe') \
    -> extract_ipv4_addresses \
        -> to_xml
```



Compute MD5, SHA1, CRC32, and FileType

```
from_file('malware.exe') \
    -> md5sum \
        -> sha1sum \
            -> crc32 \
                -> file_type \
                    -> to_xml
```



Other (Potential) Security Domains:

- Reverse Engineering
- Malware Analysis
- Penetration Testing
- Intelligence Gathering
- Fuzzing
- Etc.

Moving on!

Hackersh

Hackersh

- *Hackersh* is a portmanteau of the words Hacker and Shell
- Shell (command interpreter) written with Pythonect-like syntax, built-in security commands, and out of the box wrappers for various security tools
- Current “stable“ version (True to May 15 2013): 0.2.0
- Made available under GNU General Public License v2 or later
- Influenced by: Unix Shell Scripting and Pythonect
- Cross-platform (should run on any Python supported platform)
- Website: http://www.hackersh.org

Motivation

- ~~Taking over the world~~
- Automating security tasks and reusing code as much as possible

Problems

- There are many good security tools out there...
  - but only a few can take the others output and run on it
  - but only a few of them give you built-in threads/processes controling for best results

- No matter how well you write your shell script, the next time you need to use it - for something slightly different - you will have to re-write it

Hackersh – The Solution

- Hackersh provides a “Standard Library“ where you can access your favorite security tools (as Components) and program them as easy as a Lego
- Hackersh lets you automagically scale your flows, using multithreading, multiprocessing, and even a Cloud
- Hackersh (using Pythonect as it's scripting engine) gives you the maximum flexibility to re-use your previous code while working on a new slightly-different version/script

Installing and Using The Hackersh

- Install directly from PyPI using easy_install or pip:
  - `easy_install Hackersh`

    OR
  - `pip install Hackersh`
- Clone the git repository:
  - `git clone git://github.com/ikotler/hackersh.git`
  - `cd hackersh`
  - `python setup.py install`

Implementation

- Component-based software engineering
  - External Components
    - Nmap
    - W3af
    - Etc.
  - Internal Components
    - URL (i.e. Convert String to URL)
    - IPv4_Address (i.e. Convert String to IPv4 Adress)
    - Etc.

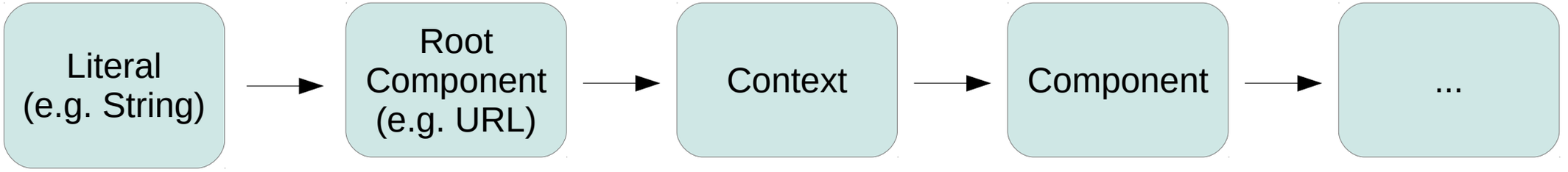
Input/Output: Context

- Every Hackersh component (except the Hackersh Root Component) is standardized to accept and return the same data structure – Context.
- Context is a dict (i.e. associative array) that can be piped through different components
- Context stores both Data and Metadata
- The Metadata aspect enables potential AI applications to fine-tune their service selection strategy based on service-specific characteristics

Conditional Flow

```
"http://localhost" \
    -> url \
        -> nmap \
            -> [_['PORT'] == '8080' and _['SERVICE'] == 'HTTP'] \
                -> w3af \
                    -> print
```

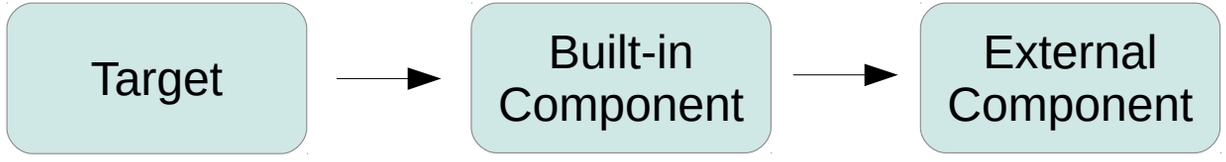
Hackersh High-level Diagram



<Hackersh Scripts/Examples>

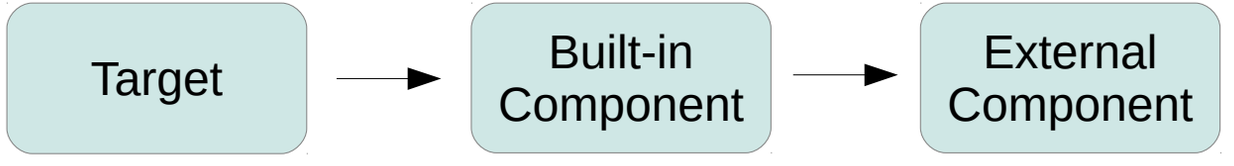
TCP & UDP Ports Scanning

```
"localhost" -> hostname -> nmap
```



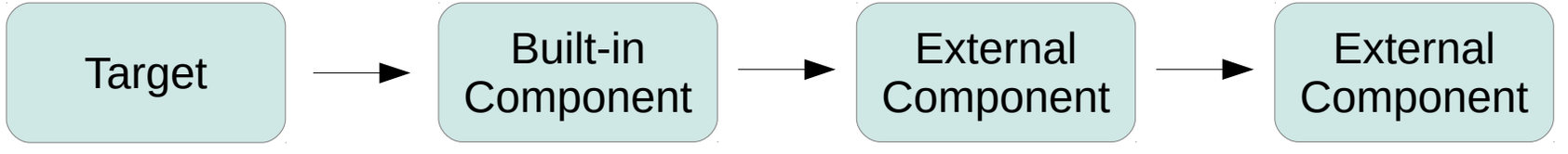
Class C (256 Hosts) Ping Sweep

```
'192.168.1.0/24' -> ipv4_range -> ping
```



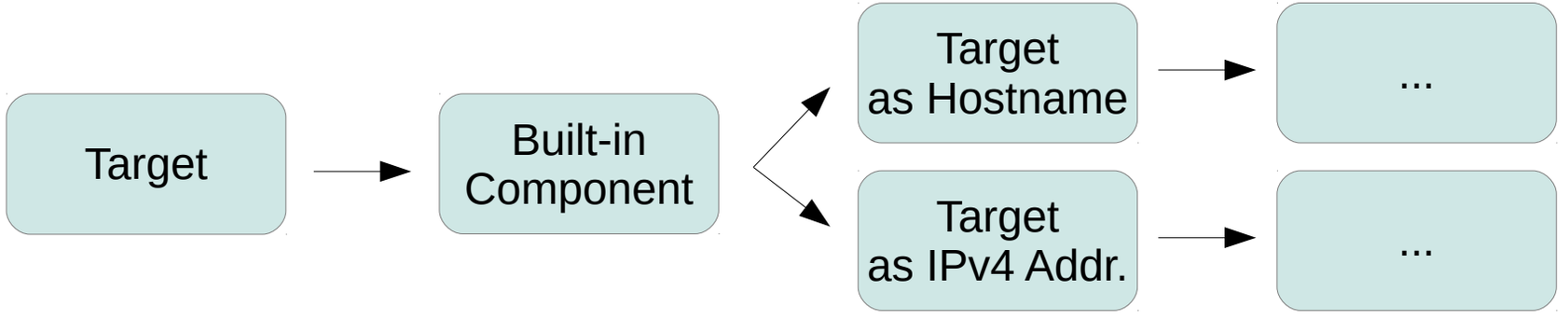
Web Server Vulnerability Scanner

```
'127.0.0.1' -> ipv4_address -> nmap -> nikto
```



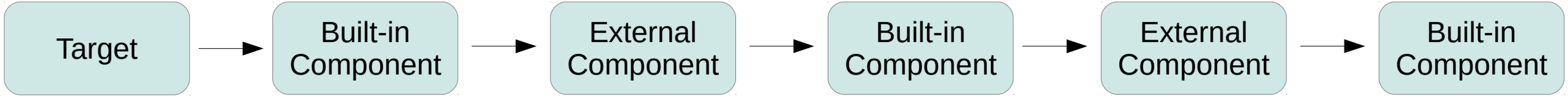
Fork: Target as Hostname + Target as IP

```
"localhost" \
    -> hostname \
        -> [nslookup, pass] -> ...
```



Black-box Web App Pentration Testing

```
"http://localhost" \
     -> url \
     -> nmap \
     -> browse \
     -> w3af \
     -> print
```



Hackersh Roadmap

- Unit Tests
- Documention
- More Tools
  - Metasploit
  - OpenVAS
  - TheHarvester
  - Hydra
  - …
- Builtin Commands
- Plugins System
- **<YOUR IDEA HERE>**

Hackersh Official TODO

https://github.com/ikotler/hackersh/blob/master/doc/TODO

Questions?

Thank you!

My Twitter: @itzikkotler
My Email: ik@ikotler.org
My Website: http://www.ikotler.org

Pythonect Website: http://www.pythonect.org
Hackersh Website: http://www.hackersh.org

Feel free to contact me if you have any questions!